PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Apparatus and method for Performing Chemical Reactions

We, THE GAS COUNCIL, a British Body Corporate, of 4—5 Grosvenor Place, London, S.W.1, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to apparatus and a method for performing chemical reactions using what is commonly termed a "recycle" reactor. This type of reactor generally comprises a reaction vessel (the interior walls of which define a reaction zone) having mounted therein a dividing member (e.g. a mixing tube) which is shorter than the internal length of the vessel and which divides the reaction zone into at least two regions which are in communication with each other beyond the ends of the member. In use, the reactants circulate around the dividing member.

In thermally insulated recycle reactors, the walls of the reactor chamber and of the dividing member necessarily attain the same temperature as the reacting gases. It has been found that with certain reactions and with certain materials of construction this temperature is such that the walls may come to display catalytic activity and become capable of initiating reactions which are undesirable. An example is a reaction which leads to the deposition of carbon in the hydrogenation of light petroleum distillate.

It is therefore advantageous to provide means for controlling the temperature of the internal surfaces of these reaction vessels so that temperatures at which such undesirable reactions can start are not attained.

Accordingly the present invention provides in one aspect apparatus for performing chemical reactions comprising a reaction zone defined by the interior walls of a reaction vessel, a dividing member which is shorter than the internal length of the vessel and which provides a mixing zone for the reactants and divides the reaction zone into at least two regions which are in communication with each other beyond the ends of the member, means for introducing reactants in fluid form into the reaction zone at such a velocity that a continuous circulation of a substantial body of fluid comprising reactants and reaction products is established within the reaction zone, means for removing reaction products from the reaction zone, and means for cooling at least one interior surface in the reaction vessel. The invention is of particular importance when reactants and reaction products are in the vapour phase.

The general shape of the reaction vessel may be as described in any of our Specifications Nos. 1031717, 1085613 and 1074932. Thus, the reaction vessel may be generally cylindrical and may have mounted within it a mixing tube, being a hollow cylindrical member or a venturi, which is shorter than the internal length of the vessel and which divides the reaction zone into an inner region of circular cross-section and an outer region of annular cross-section, the two regions being in communication with each other beyond the ends of the mixing tube. In this case, the mixing tube is defined as forming part of the reaction vessel whose walls define the reaction zone.

Alternatively, the reaction zone may have a toroidal shape, and optionally part of the zone may have the shape of a venturi. Alternatively, the reaction zone may have any other desired shape and may be provided with baffles, vanes or other devices for reducing the loss of energy involved in changing the direction of the gas flow.

In apparatus according to the invention, either the wall of the vessel, of the mixing tube, or both, may be of double-walled construction. The spaces enclosed between the double walls may contain no solid material and, when the apparatus is in use, a cooling fluid may be passed through them; alternatively, the double walls may enclose, optionally

[*Price 4s. 6d.*]

helical, coils of tubing (through which a cooling fluid can pass) which may be wound to any desired spacing. In alternative apparatus, either the wall of the reaction vessel or the mixing tube or both may consist of close wound coils of tubing. If desired, any combination of these means to cool the interior walls may be used. In embodiments of this invention in which there are wound coils within double-walled enclosures, the space between the coils may be filled with a suitable heat transfer medium to facilitate the transfer of heat from the walls to the coils.

In carrying out processes in such reactors, a cooling fluid is caused to flow through the spaces within the walls or through the coils. The cooling space in the reactor wall may be connected in series with the space in the mixing tube, and flow may be in either direction; alternatively, the spaces may be connected in parallel, or they may be independent and provided with separate sources of cooling fluid.

The fluids used may be reactants, which are caused to flow through the cooling spaces before they are admitted to the reaction zone, but any suitable cooling fluid may be used.

In general, the passage of fluids through cooling means such as compartments or coils can be used to abstract heat from the system, and, when this is desired, the apparatus will be designed for appropriate heat transfer rates, which may be high rates, from the reaction space to the surfaces and from the surfaces to the cooling fluid.

Advantageously, however, with certain chemical reactions, the apparatus will be designed to provide the desired degree of cooling while abstracting the minimum of heat. This can be achieved by minimising heat transfer rates from the reaction space to the surfaces, without necessarily having a low heat transfer rate between the wall and the cooling fluid. Means of reducing the rate of abstraction of heat include designing the reactor to have a minimal internal surface area and reducing as far as is practicable the velocities of fluid flowing within it.

The invention also includes a method of performing chemical reactions wherein reactants in fluid form are continuously introduced into a reaction zone (defined by the interior walls of a reaction vessel and divided by a dividing member, which is shorter than the internal length of the vessel and which provides a mixing zone for the reactants, into at least two regions which are in communication with each other beyond the ends of the member) at such a velocity that a continuous circulation of a substantial body of fluid comprising reactants and reaction products is established within the reaction zone, and wherein at least one interior surface of the reaction vessel is cooled. In particular this method may be applied to the hydrogenation of a hydrocarbon feedstock, for example light petroleum distillate, whereby deposit of carbon on the interior surfaces of the reaction vessel is substantially avoided.

The invention is illustrated by Figures 1 to 3 of the accompanying drawings each of which shows a sectional side elevation of a recycle reactor, comprising a reaction zone 9 defined by a reaction vessel 10, a mixing tube 11, an inlet orifice 12 and an outlet for reaction products 13.

In Figure 1, the walls of the reaction vessel 10 and of the mixing tube 11 are of double-walled construction and provision (not shown) is made for the passage of a cooling fluid through the annuli so formed.

In Figure 2, the end walls 14 of the reaction vessel are insulated, but the side walls 15 and the mixing tube 11 are of double walled construction, and enclose helical coils of tubing 16 through which a cooling fluid can flow.

In Figure 3, the end walls 14 of the reaction vessel are insulated, but the side walls 15 and the mixing tube 11 consist of close wound coils of tubing through which a cooling fluid can flow.

WHAT WE CLAIM IS:—

1. Apparatus for performing chemical reactions comprising a reaction zone defined by the interior walls of a reaction vessel, a dividing member which is shorter than the internal length of the vessel and which provides a mixing zone for the reactants and divides the reaction zone into at least two regions which are in communication with each other beyond the ends of the member, means for introducing reactants in fluid form into the reaction zone at such a velocity that a continuous circulation of a substantial body of fluid comprising reactants and reaction products is established within the reaction zone, means for removing reaction products from the reaction zone, and means for cooling at least one interior surface in the reaction vessel.

2. Apparatus as claimed in claim 1 wherein the reaction vessel is generally cylindrical and has mounted within it a mixing tube, being a hollow cylindrical member or a venturi, which is shorter than the internal length of the vessel and which divides the reaction zone into an inner region of circular cross-section and an outer region of annular cross-section, the two regions being in communication with each other beyond the ends of the mixing tube.

3. Apparatus as claimed in claim 1 wherein the reaction zone has a toroidal shape.

4. Apparatus as claimed in any one of the preceding claims wherein the reaction zone is provided with baffles, vanes, or other devices for reducing the loss of energy involved in changing the direction of the gas flow.

5. Apparatus as claimed in any one of claims 1 to 4 wherein either the wall of the vessel, or the mixing tube, or both, are of double-walled construction.

6. Apparatus as claimed in claim 5 wherein the spaces enclosed between the double walls

contain no solid material and there is provision for the passage of a cooling fluid between the walls.

7. Apparatus as claimed in claim 5 wherein the double walls enclose, optionally helical, coils of tubing, and there is provision for the passage of a cooling fluid through the tubing.

8. Apparatus as claimed in claim 7 wherein the space between the coils is filled with a heat transfer medium.

9. Apparatus as claimed in any one of claims 1 to 4 wherein the wall of the reaction vessel, or the dividing member, or both, consist of close-wound coils of tubing, and there is provision for the passage of a cooling fluid through the tubing.

10. Apparatus as claimed in claim 1 and substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

11. A method of performing chemical reactions wherein reactants in fluid form are continuously introduced into a reaction zone (defined by the interior walls of a reaction vessel and divided by a dividing member, which is shorter than the internal length of the vessel and which provides a rinsing zone for the reactants, into at least two regions which are in communication with each other beyond the ends of the member) at such a velocity that a continuous circulation of a substantial body of fluid comprising reactants and reaction products is established within the reaction zone, and wherein at least one interior surface of the reaction vessel is cooled.

12. A method as claimed in claim 11 when performed in the apparatus claimed in any one of claims 1 to 10.

13. A method as claimed in claim 11 or 12 when applied to the hydrogenation of a hydrocarbon feedstock, for example light petroleum distillate, whereby deposition of carbon on the interior surfaces of the reaction vessel is substantially avoided.

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1 SHEET

Fig.1.

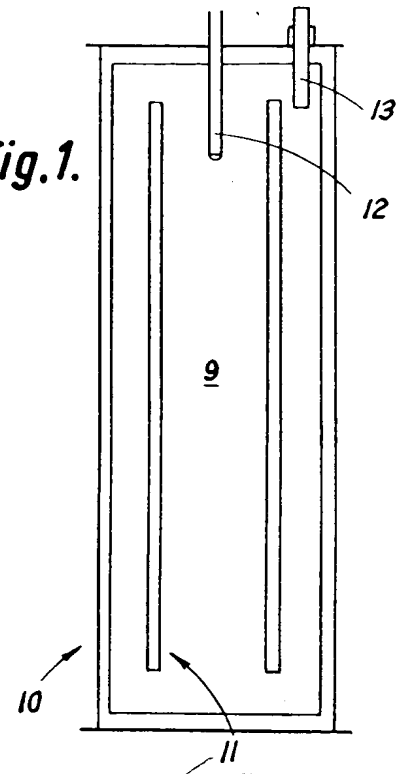

Fig.2.

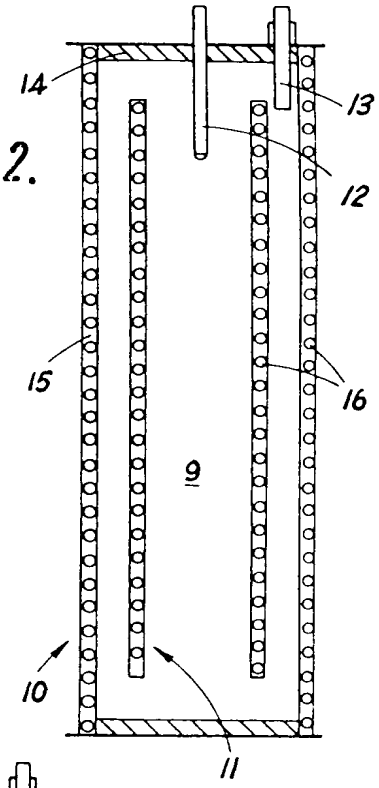

Fig.3.